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INTERNET-BASED TRAINING: LEARNER PERFORMANCE AND INSTRUCTIONAL FEEDBACK

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ABSTRACT

An experiment that examined the use of the Internet for training digital skills is analyzed in this report. A distributed digital skills laboratory was created using low bandwidth media for the delivery of instruction related to military messaging systems. A sample of n=147 military personnel and civilians were trained in a one-day course which included a brief lecture and a lengthy hands-on laboratory. The sample included those trained in a traditional classroom and those trained through distance learning delivered over the Internet using instant messaging as a feedback mechanism. The results demonstrated equal performance between groups.

1. INTRODUCTION

The Army plans to convert more than 500 courses to a distance-learning format during the next decade, delivering training to a soldier when needed through distance learning technologies. In the 21st century, soldiers will attend streamlined resident courses, preparing themselves through synchronous and asynchronous learning modules delivered at unit learning centers, at the job site, or in their residences. Much of this training will be delivered over the Internet or through military intranets. The advantages of training from a distance include a reduction in travel costs to a central facility and greater flexibility in scheduling.

An underlying assumption is that the quality of training is maintained whenever and wherever it is delivered to the soldier. Learning outcomes from a distance learning program must be on par with those from classroom instruction, if not better. A challenge of training from a distance, then, is providing informative feedback, a critical condition for learning, to soldiers about their performance, helping them to proceed more effectively.

1.1 Distributed Learning

The Office of the Under Secretary of Defense for Personnel and Readiness (1999) defines distributed learning as "structured learning that takes place without the physical presence of the instructor." The Department of Defense also stresses the importance of right-time, right-place learning. The United States Army Training and Doctrine Command (1998) further defines distance learning (DL) as:

> *"...delivering standardized training using multiple media and technologies when and where it is needed. It includes providing individual, collective, and self-development training to Army members and units. Distance learning may involve student-instructor interaction in both real time (synchronous) and non-real time (asynchronous)."*

Distributed learning, essentially synonymous with DL, has the potential to dramatically enhance organizational performance by increasing personnel qualifications in the unit and mitigating the impact of skill decay. The ability to conduct pre-deployment, mission-specific training through widely available communications networks can result in faster preparation of soldiers for contingencies. This training can cover many types of tasks, from individual soldiering skills to collaborative teamwork execises.

1.2 Current System Shortfall

The soldier of the future will be surrounded by digital systems. The successful operation of these systems will require proficiency in digital skills. Digital skills are defined as those learned behaviors that allow a trainee to interact with a computer in order to accomplish a task (Dressel & Macpherson, 2000). Because training

is most effective when it is one-on-one, the training of many digital skills can benefit from real-time, one-on-one interaction and feedback using both instructor and student computer screens along with audio and video. However, current military distributed learning programs provide limited opportunities for guided practice and individual coaching in a learning laboratory environment.

1.3 The Hybrid Approach

Historically, distance learning has embraced many approaches to learning, from correspondence courses to intelligent tutoring operations. The future delivery of distance learning is clearly in networks and connectivity. However, the current Internet bandwidth and access speeds are inadequate for the delivery of true multimedia instruction combining sound, video, graphics and data. Hybrid approaches to distance learning use a combination of technologies to increase capacity and choice in designing and delivering instruction. (Kidwell, 1998).

2. DISTRIBUTED DIGITAL SKILLS LABORATORY

The proliferation of inexpensive personal computers capable of rendering high-quality graphics, the adoption of international standards for multimedia conferencing, and the ubiquity of Internet access have resulted in the opportunity to create affordable, effective, distributed digital skills laboratories (D2SL).

The D2SL concept provides the capability to interact in a form that enables synchronous, instructor-led-and-coached training of software-based digital skills. The training originates at a distance in a distributed classroom laboratory environment. This includes replication of the primary instructor's screen to all remote learners and replication of each remote learner's screen to the instructor's site. Audio and video between the instructor and remote learners also are shared. Interactions are accomplished simultaneously using a hybrid approach of stable technologies and multiple low bandwidth media (such as plain analog telephone lines and narrow band Internet connections), thus increasing access while controlling costs.

The D2SL creates virtual learning environments for each student within the conversational framework of a larger, shared computer laboratory. The instructors and coaches interact with the learners collectively in the computer laboratory construct and individually in each learner's virtual learning environment. As described later in the experiment, the provision of three instructor-and-student interactions (audio, video, instructor screen, learner screen) creates a near-immersive distributed digital skills learning environment conducive to one-on-one coaching for training digital skills training.

2.1 International Standards

The D2SL uses the International Telecommunications Union (ITU) family of digital conferencing standards known as H.32X. These standards provide rich multimedia conferencing interoperability with integrated audio-video and data communication. However, the only component with guaranteed reliable transmission over the Internet is the T.120 data conferencing standard. Therefore, data conferencing is the most dependable method of shared visual digital interaction currently available over the Internet (The International Multimedia Teleconferencing Consortium, Inc, 1997).

Using separate analog telephone lines provides quality of service for the audio and video channels by creating direct circuits in which all information is carried along the same routes for the duration of the call. This ensures high-fidelity, real-time voice interaction with somewhat lower resolution and frame rate video at a relatively low cost. This approach to providing the voice channel results in more effective and interactive teleconferences since the quality of audio is the highest determinant of participant satisfaction (Tang & Isaacs, 1992). Video motion is unnecessary in training unless the task being trained requires that attention is directed to relevant features that change, or motion allows discriminations to be made, or when the task is difficult to express verbally (Wetzel, Radtke and Stern, 1994). Since the motion video of participants is useful primarily for revealing classroom cues for the instructor and enhancing learner satisfaction, but has little effect on actual learning performance, the lowest bandwidth method for providing for reliable connections and discernible visual cues is preferred (Freeman, Wisher, Curnow & Morris, 1999).

3. D2SL PROVISIONS FOR INTERACTION

The following provisions for interaction are provided simultaneously in the D2SL concept (see Figure 1). Informative feedback is provided through instant messaging technology, as described later.

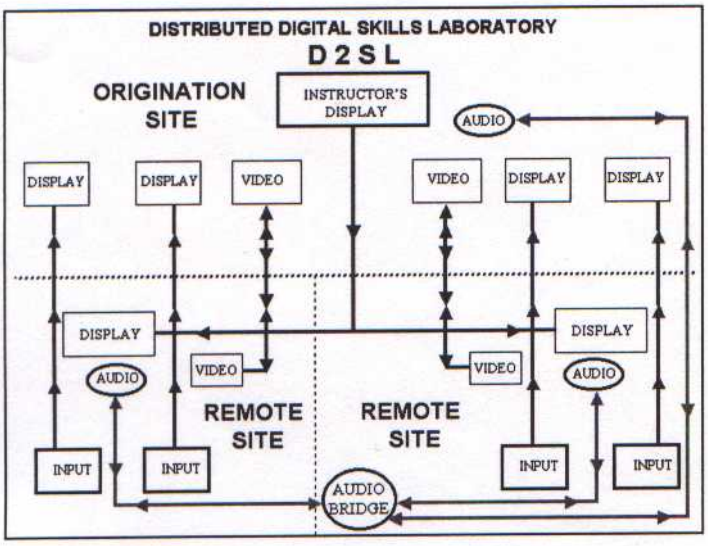

Figure 1. Typical Distributed Digital Skills Laboratory Connectivity.

3.1 Instructor and Learner Video

The two-way, interactive video of the instructors and each remote learner site is provided through a single, plain, analog telephone line using an ITU H.324 compatible video appliance. Although not used in this study, a multipoint conference unit can be employed to provide continuous presence viewing of all participating sites.

3.2 Instructor and Learner Audio

The two-way, interactive audio of all participants is provided through a single plain, analog telephone line and a high-quality, full-duplex speakerphone at each site linked with a multipoint audio conference bridge. Delivering audio and video over separate lines allows best use of the limited bandwidth analog telephone system while providing redundant circuits in case of problems.

3.3 Instructor Screen Replication to each Remote Learner Site

The two-way, interactive replication of the primary instructor's screen to a computer with large display at each remote learner site is accomplished through the whiteboard and collaboration transparent application sharing functions described in the ITU T.120 standard. The instructor uses this screen to provide learners graphical representations of instructionally-significant information and to demonstrate functions of the subject digital skills. The instructor also can turn control of the application over to learners one at a time for manipulation and viewing by all sites.

3.4 Remote Learner Screen Replication to the Instructor Site

The two-way, interactive replication of each learner's screen to a separate computer screen at the instructor site is accomplished through the whiteboarding and collaboration transparent application sharing functions described in the ITU T.120 standard. The instructor uses this screen to independently view each learner's performance while practicing a digital skill. The instructor and coaches also can take control of each learner's application independently for manipulation and demonstrating correct performance to each student individually.

3.5 Remote Learner Instant Messaging with the Instructor Site

The chat or instant messaging function of the T.120 standard is provided for students to ask questions of the instructor and for the instructor to privately coach /assist each student. The text-based instant message function offers a private, mixed initiative (either party can initiate) dialog for student-instructor interaction, not interrupting the learning progress of other students.

4. EFFECTIVENESS

Innovative learning tools for education and training continue to evolve and expand. The proliferation of web courseware technologies, as well as the addition of clever technologies to deliver content to remote sites, multiplies the opportunities and challenges facing higher education as well as training environments (Gray, 1999). The effectiveness of these new training approaches, however, must be assessed to determine if the outcomes are matching the promises. In an examination of the literature on the effectiveness of distance learning, Wisher and Champagne (2000) identified substantial shortcomings in evaluations of the effectiveness of distance learning. These included the lack of comparison groups, weak experimental designs, and non-objective learning measures. Guidelines to consider in evaluating courses, particularly short courses of only a few days, are provided in Wisher and Curnow (1998). Also, the unique opportunities that the military training culture offers in measuring training effectiveness (Curnow & Wisher, 2000), notably the use of utility judgments as a surrogate measure of learning outcomes, should be considered in any evaluation conducted in military settings.

5. THE EXPERIMENT

The effectiveness of the distributed digital skills laboratory for training the digital skills of the United States Message Text Format (USMTF) system was measured in an experiment conducted by the U.S. Army

Research Institute for the Behavioral and Social Sciences (ARI), in conjunction with the U.S. Army Reserve Readiness Training Center (ARRTC), Fort McCoy, WI. The experiment was planned and coordinated by the Office of Strategic Initiatives, Office of the Chief of Army Reserve, with technical assistance from the Training Division, Deputy Chief of Staff for Operations, U.S. Army Forces Command (FORSCOM). The FORSCOM Joint Multi-TADIL School provided all instructors and courseware.

The experiment used the D2SL as described above. The course was taught by a triad of highly-seasoned instructors, each having taught the course more than 50 times in a traditional face-to-face classroom setting. The current experiment was the instructors' first experience with a distributed learning mode of delivery. The experimental treatment group used the D2SL and the comparison group was trained in the traditional face-to-face classroom. A mixture of military personnel from the Army and Marine Corps were participants, along with a smaller number of military civilians. A total sample of n =147 was tested.

5.1 Experimental Approach

Course

The course consisted of a one-hour lecture on the purpose of the USMTF followed by a hands-on laboratory that required up to five hours. For this laboratory, each student individually composed multiple messages on a personal computer. The objective of the course was to enable users to produce and deliver a valid USMTF message. A key enabling objective was to understand the composition of a message. This required the ability to identify the structural components of a message (segments, sets, and fields) and to become familiar with the rules for structuring these components. Also required were an understanding of different message formats, occurrence categories, special use characters, and correction of message errors. Since there are hundreds of message types, the hands-on portion of the training required that only a representative sample be executed during the training period. The hands-on portion of training was conducted individually on a personal computer linked to the Internet. Upon successful completion of the sample messages, students were awarded a certificate of completion.

The traditional face-to-face classes were conducted at F ORSCOM in Atlanta, GA, and at Marine Corps Air Ground Combat Center, Camp Pendleton, CA. The D2SL version of the course originated from the ARRTC. Three remote sites participated in the DL training: Fort Leavenworth, KS, Fort Hood, TX, and the 84th Division Headquarters, Milwaukee, WI. There were a total of six iterations for the traditional class and three for the DL version. There were no fundamental alterations to the content of the course when delivered through the DL mode, so there were no costs to convert the course content to the DL mode.

Instructors

For the D2SL version, three instructors were used. One instructor provided the one-hour overview lecture. For the hands-on laboratory, a cluster of five personal computers was arranged in a semicircle. Each computer within a cluster corresponded to a personal computer at a remote site. This enabled the screen contents at the remote site to be replicated at the origination site. Three such clusters were available, one for each remote site. Each cluster had a separate instructor available to observe the students' progress on composing USMTF messages by scanning the monitors. When information was entered correctly, it appeared in green font. When it was entered incorrectly, or not yet entered, the designated area displayed a series of red hash marks. An instant messaging function was established which allowed the instructor to communicate immediately with each individual student. Thus, each instructor was able to coach, in real time, the students' attempts at composing a particular message. The student instructor ratio was approximately 4.2 to 1.

For the traditional classroom approach, the same three instructors provided the training. The same procedure of a one-hour lecture followed by a hands-on laboratory was followed. All three instructors were available to observe students' performance in composing messages at their individual personal computers, and answer questions when called upon. The student instructor ratio was approximately 4.7 to 1.

Each of the remote sites were equipped with:

(1) an audio conferencing device for clear, two-way audio transmitted over an audio bridge connection;

(2) a personal computer and image projector to display slides transmitted over the Internet;

(3) a television monitor providing a live image of the instructor transmitted by compressed video over a commercial telephone line. The platform instructor at the origination site was able to view live images of the three classes through three television monitors. The slides were forwarded to the remote sites using the T.120 component of Microsoft NetMeeting software in a peer-to-peer connection;

(4) a suite of five personal computers, each connected through NetMeeting to a personal computer at the remote site for use during the hands-on laboratory.

The origination site was equipped with an audio conferencing device, a personal computer to control the transmission of slides during the hour-long lecture and demonstrate software during the guided practice, three

television monitors, each providing a live image of the remote classrooms, and 15 personal computers arranged in the clusters described above.

6. EVALUATION

A pre-course questionnaire was administered immediately before the training began. The survey gathered demographic information on the participants, ratings of prior knowledge on the key course topics, and ratings of skill with software applications (such as word processing) and specific functions within an application (such as the paste function) that could transfer to the message composition task. At the end of training, performance on the hands-on tasks were recorded and an assessment of how much more was learned on key topics was gained through a questionnaire.

6.1 Demographics

A sample of n=38 participated in the DL version, and a sample of n=109 participated in the traditional classroom version of the course. Breakouts of the two samples are provided below, first by rank:

Rank	DL	Traditional
Enlisted	63%	74%
Officer	19%	9%
Civilian	18%	17%

A Chi-Square test showed no significant difference between the distribution of ranks for the groups (χ^2 = 2.63, p = .27). A second test group equality was the measurement of skills related to the use of the USMTF system. This was measured through a utility judgment of proficiency at three key skill areas, rated on a five-point scale, in which 1 is "not at all" and 5 is "very well":

Related skills	DL	Traditional
Import text	3.1	3.4
Touch type	3.3	3.3
Use cut and paste	4.0	4.3

None of the differences in related skill proficiency between the DL and traditional classroom samples were statistically significant (p>. 05 for each independent t-test). The third measure of comparability between groups is prior knowledge on specific topics in the course. This was measured through a utility judgment of prior knowledge ("how well do you know?) on five key topic areas, as rated individually through a five-point scale in which one is "not at all" and five is "very well":

Topic area	DL	Traditional
Message structure	2.2	2.7
Message composition	2.2	2.7
Message delivery	2.1	2.7
Different msg formats	2.0	2.3
Fix message errors	1.9	2.5

The only topic for which the average ratings between groups were significantly different was the "fix message errors topic" (t = 2.7, p < .01). Taken together, the differences of rank, related skill, and prior knowledge are negligible between groups.

6.2 Performance Results

For each group, the performance on the hands-on laboratory was 100 percent. All students were able to compose the required sample messages. Since hands-on performance was comparable, secondary measures of learning outcomes were analyzed to test for any potential differences. Specifically, students were asked to rate how much more they learned, compared to what they previously knew, on five topic areas, using a five-point scale, where one indicates "nothing more" to five indicating "a lot more":

Topic area	DL	Traditional
Message structure	4.0	4.1
Message composition	4.1	4.1
Message delivery	3.5	3.7
Different msg formats	4.2	4.3
Fix message errors	3.6	3.9

Of these five topics, only the "fix message errors topic" showed a significant mean difference between groups (t = 2.1, p < .05).

An overall measure of amount learned during the course was asked, again using the five-point scale. Responses of 1 or 2 were coded as "little" was learned, responses of 3 were coded as "some" was learned, and responses of 4 or 5 were coded as "a lot" was learned. The patterns for each treatment are presented below:

	DL	Traditional
Little	12%	13%
Some	18%	25%
A lot	70%	62%

The patterns are similar, with the majority of students reporting learning "a lot." There were no statistical differences in the distribution of responses between the two groups.

6.3 Instant Messaging Results

Instant messaging is a relatively new Internet application that enables users to create their own private chat room. Instant messaging (IM) is the preferred medium of immediate communication between users. In the present experiment, IM was enabled between instructors and students such that the instructor assigned to monitor a particular remote site was able to

"converse" with a student through a textbox. When students were having problems, they issued an IM. Also, when the student appeared to be stuck on a message, the instructor was able to issue an IM to that student. A coaching dialogue would ensue and the problem would be rectified. During the D2SL course, complete records of the IM transactions were available for two days at each of the three remote sites. This yielded a total of 650 messages. Two examples of message exchanges between *Student (S)* and Instructor (I) are listed below:

Example One
S: Can one send this message through the DMS systems without saving it on a diskette if DMS is loaded on your system?

I: You will be able to use this software in support of DMS. You will not have to save to disk…I know, you are saying "GREAT!"

Example Two
S: Is there a database file that tells us what the acronyms stand for in the Message Template?

I: The best "official" source is the Joint User's Handbook. The "best" source, however, would probably be the browser we have out on the website.

S: Thank you

An analysis of the 650 messages during the hands-on laboratory indicated an average message length (in words) as 7 for the 244 messages sent by students and 14 for the 406 messages sent by instructors. A best-fit normalized graph (i.e. equal area) of the distributions of message length for the students (dashed line) and instructors (solid line) is presented in Figure 2 below.

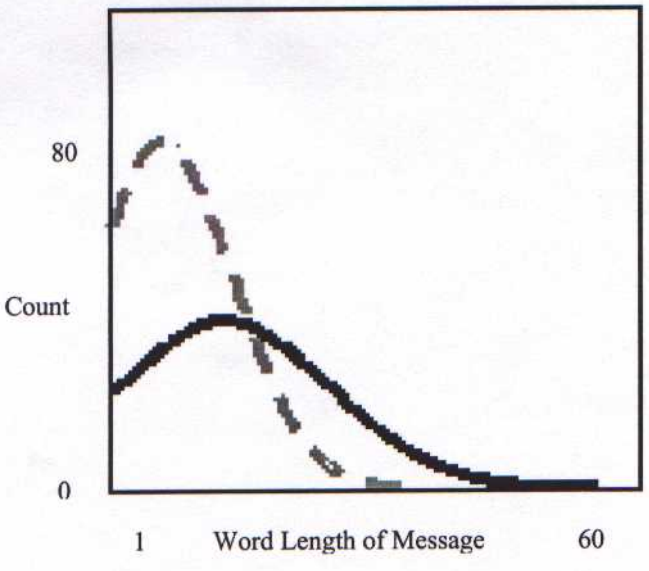

Figure 2. Normalized distributions of message length.

The graph illustrates that for students, a greater proportion of messages were relatively shorter in length when compared to messages sent by instructors. An examination of the messages revealed that most were answers to a brief question by the student (e.g., "What do I do next?"). The instructors issued about 1.7 messages for each student message. Overall, the fact that instructors sent many more messages reflects the prompting and coaching that occurred during the laboratory exercises.

Another measure of the effectiveness of the IM technology was with the student rating of "responsiveness to questions" on a five-point scale. For the DL group, this was rated at 4.6 in contrast to a rating of 4.8 for the traditional classroom group (not statistically significant). However, the usefulness of feedback was rated slightly higher for the traditional classroom group, 4.8 compared to 4.5 for the DL group. Although this difference reached statistical significance, the high rating for the D2SL, when compared to other forms of DL, indicates a positive response to the training technology.

7. DISCUSSION OF FINDINGS

This experiment illustrates the value of the D2SL for training digital skills at a distance. Every student was able to succeed at the hands-on exercises without the physical presence of the instructor. Importantly, the IM technology was an effective feedback alternative to the personalized verbal feedback a student receives in the traditional classroom. This technology allows questions to be posed by either the student or the instructor, and feedback is immediate. From an experimental standpoint, the dialogues are captured in electronic form and can provide as feedback to the instructional designer. The commonly asked questions can serve as a basis for a "frequently-asked-question" performance aid for learning.

The value of being able to ask questions and receive feedback should not be underestimated in a distributed learning environment. Question asking is a central component of theories of learning, cognition, and education (Graesser & Person, 1994). However, it is well established that in traditional classrooms, question asking is infrequent and unsophisticated. For example, estimates for the average number of questions asked per instructional hour ranges from 1.3 to 4.0, with a median of 3.0 (Graesser & Person, 1994). When considering the average class size, this translates into a frequency of about .11 questions per hour per student (Dillon, 1988). For the IM coaching environment, the messages were classified as either questions or other types of interactions. Results of this informal analysis indicated that the frequency was .61 questions per hour per

student, more than five times the historical rate of questions in traditional classrooms.

On a more generic level, the exchange of messages, or chats, that occur between student and instructor may be considered forms of interactions. Wagner (1997) defines an interaction as reciprocal events requiring two objects (e.g., student and instructor) and two actions (e.g., a message and a reply). Such interactions foster behaviors in which individuals and groups influence one another. Question asking is one form of interaction. Wagner (1997) identifies 13 types of interactions that can occur in distance learning, such as interactions to increase participation, to develop communication, or to receive feedback. The hallmark of interactions is that they must result in the transfer of knowledge or a change in intrinsic motivation. For the present experiment, it is plausible to consider each IM an interaction. On the basis of the 650 IMs, then, there was an average of 7.74 interactions per student per hour. How this figure compares to other forms of instruction cannot be determined as there is little quantitative documentation in the literature on frequency of interactions.

The experiment reported here conformed to the experimental guidelines outlined by Wisher and Champagne (2000). Comparison groups were used, a surrogate measure of prior knowledge appropriate for military training was employed in the absence of a pre-test, and objective performance testing (hands-on performance on a digital skill exercise) was conducted and supplemented by a secondary measure of learning outcome - utility judgments.

8. SUMMARY

Distributed learning has the potential to enhance individual competency and unit readiness by delivering learning where and when needed. However, distributed learning systems must provide the interactions and informative feedback required to satisfy all instructional objectives. The D2SL is a viable method for training and coaching digital skills hands-on at a distance while maintaining training effectiveness. It also has potential to be an effective tool for training other types of skills.

DISCLAIMER: The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Army.

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